TABLE 1.—*Continued.*

Date, Localities, Soil.	Geological Formation of Soil.	*Azotobacter* p.g. of Soil.	*Beijerinckia* p.g. of Soil.	pH.	P. (1) Mg./kg.	P. (2) Mg./kg.	C. G./kg. of Soil.
(46) 29.7.52. 20 miles south of Rockhampton. Alluvial soil adjoining dam. Open semi-cultivated land with light timber.	—	—	—	5·3	—	—	25·0
(47) 29.7.52. 20 miles north of Gladstone. Brown shale. Coastal open forest with grass.	—	—	—	5·7	—	—	20·0
(48) 27.7.52. 40 miles north of Claremont. Black (?) alluvial soil. Dry sclerophyll forest.	—	—	—	5·75	—	—	5·5

The soil samples were collected from that portion of the route from the eastern Kimberleys, north-west coast, sclerophyll woodlands southwards along the Stuart Highway and semi-desert terrain eastwards on the Barkley Highway, western Queensland, to the rain forests of north-east Queensland.

The geographic distribution of *Beijerinckia* in Australia seems to be limited at 17–18° latitude. Of the 15 samples collected around the 19·5° latitude only one gave positive growth of *Beijerinckia*. It is possible that no *Beijerinckia* was detected south of 20° latitude. It should be kept in mind that the soil samples examined were in limited number for such a big area. However, if McKnight's results are compiled with the present investigation, it seems that *Beijerinckia* does not occur south of the Tropic of Capricorn. It is important and very desirable to test more soil samples between 17° and 20° latitude in Australia before a definite conclusion can be made. The limit of 17–18° latitude may be used as a starting point for further investigations.

TABLE 2.

Authors.	Localities.	% Soil Containing *Azotobacter.*	% Soil Containing *Beijerinckia.*
Jensen	New South Wales ..	25	—
McKnight	Queensland..	43·15	—
Swaby	Victoria	26·15	—
Tchan	Sydney	22	—
Tchan	Northern Australia ..	15	35

The ecological conditions of *Beijerinckia* in Australia are not understood. The soil type and its parent material in positive cases are indeed very variable (see Table 1). The analysis of C, P content and pH of soil samples did not show any correlation between presence and absence or number of *Beijerinckia* per g. of soil. On the other hand, *Azotobacter* did not occur at pH less than 5·5 except in one case of sporadic presence of *Azotobacter* at pH = 5·1. The climatic environments have no apparent influence on the presence of *Beijerinckia*.

It is clear that *Beijerinckia* can survive in low rainfall countries. The drought of 1952 in Northern Australia provided an example. Also in high rainfall country outside the tropical zone (Brisbane, Sydney, etc.) *Beijerinckia* seems to be absent (see Text-figure 1). Temperature cannot be considered as an important ecological factor in its distribution, since the occurrence of *Beijerinckia* took place in certain places where the

mean minimum temperature of 57·2°F. (14°C.) is lower than certain places outside the tropic zone, e.g. Brisbane 59·7°F. (15·4°C.).

Under the experimental conditions *Beijerinckia* (isolated from Northern Australia) inoculated into soil and kept in a refrigerator (+4°C.) survived after 36 days. As along certain parts of the east coast of Australia (Queensland, N.S.W.) the winter temperature never goes much below that limit, there is no apparent reason to believe that *Beijerinckia* could be killed during the winter.

Complete desiccation (with $CaCl_2$) in the laboratory did not destroy *Beijerinckia* in soil after 36 days, but such a severe desiccation is not likely to occur in the temperate places of the east coast of Australia. This may suggest that *Beijerinckia* may survive in air-dried soil at normal humidities.

TABLE 3.

(Data compiled from Meteorological data, C.S.I.R.O., Melbourne, 1933. Pamphlet 42.)

Soil Sample No.	Mean Temperature (°F.).		Humidity.	Rainfall. (Inches per Year.)
	+° max.	+° min.		
32	89·4	65·3	36	14·72
7	92	63·9	41	20·84
10, 14, 17, 18, 23, 25, 29 ..	94	66·7	51	26·48
38, 39, 40	89·9	64·8	52	31·97
41	78	57·2	74	51·84
19, 21	90	74·3	68	60·45
44	82·2	65·5	81	142·61
Bowen	82·6	67·2	69	39·88
Rockhampton	83·5	62·8	67	39·75
Brisbane	78·1	59·7	68	45·27
Sydney	70·2	56·2	70	47·50

If the chemical and meteorological factors could not explain the absence of *Beijerinckia* outside the tropical zone of Australia, the only remaining hypothesis will be that *Beijerinckia* is a young genus which may have been introduced to this country very recently and has not had enough time to reach the rest of the continent. This hypothesis may not be considered as a valid one, since the movement of animal and human transport in Queensland is so intensive that the contamination from Northern Queensland can be realized in a matter of months. Furthermore, information in the literature shows that *Beijerinckia* has been found only in tropical countries. Altson (1936) in Malaya was probably the first person to detect *Beijerinckia*; later it was found in Indian soils by Starkey and De (1939), in Indonesia and Pacific islands by Derx *et al.* (1950), in Africa (Kauffmann, 1953) and in South America (Derx, 1952). Outside the tropical zone the *Beijerinckia* has been sought but unsuccessfully (Northern Africa (Derx, 1952); Southern France (Derx, 1950); N.S.W. (Jensen and Swaby, 1940; Tchan, 1952)). From these data one may conclude that if *Beijerinckia* has spread so widely in the tropics, including very long distances separated by oceans, it is not likely that it needs more time to reach the Australian soils south of the tropics. It is likely that the hypothesis mentioned above has no important value.

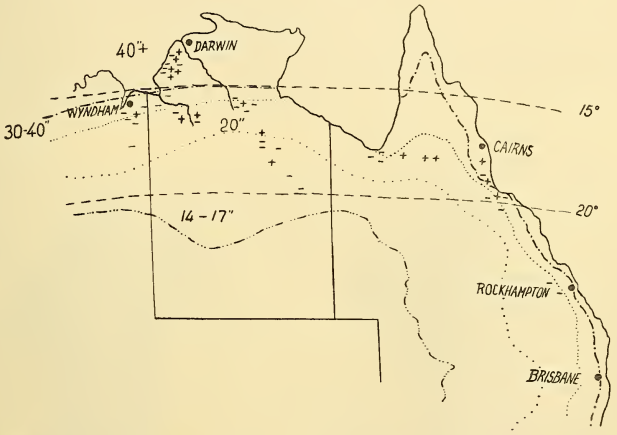
It is not clear why *Beijerinckia* is a genus confined to tropical countries.

This geographic limitation of *Beijerinckia* can be extended to the distribution of other N-fixing micro-organisms in the world. The distribution of *Rhizobium* is excluded in this paper because it is practically a question of distribution of legumes. The non-symbiotic N-fixing soil micro-organisms can be classified into four groups: blue-green algae (*Nostoc* and *Anabaena*), *Clostridium*, *Azotobacter* and *Beijerinckia*.

(1) In the tropical countries the four groups of organisms have been detected.

(2) In the temperate zone the absence of *Beijerinckia* reduces the number to three groups.

(3) In the arctic and antarctic zones the early workers have reported the presence of *Azotobacter*. Rountree (1939) reported the presence of *Azotobacter* in Macquarie Island soils, but more recently Bunt could not confirm this result with soil samples collected in most suitable conditions. Also he reported that on the N-free media the Macquarie Island soil samples gave some colonies similar in appearance to *Azotobacter*.



Text-figure 1.—Map showing distribution of *Beijerinckia*, the latitudes and the rainfall. +..... positive soil; −..... negative soil.

The early positive results may be due to contamination of soil samples. On the other hand, in Greenland, the search for *Azotobacter* has been always negative (Barthel, 1922; Jensen, 1951).

The absence of *Azotobacter* in the very cold regions could be partly explained by the death of *Azotobacter* (including cysts) at a prolonged low temperature. Wang (1949) has reported that *Azotobacter* is killed if the culture is kept in a refrigerator for a prolonged period. So the very cold regions contain only two groups of non-symbiotic N-fixing micro-organisms (blue-green algae and *Clostridium*).

This division of the world, according to the distribution of non-symbiotic N-fixing micro-organisms, into three zones is still at a purely hypothetical stage. It could only be established with some certainty if a very extensive survey in different regions could be carried out. At the present stage this suggestion may provide a starting point for future research work.

Conclusion.

The present results have contributed to our knowledge by showing that:

(1) *Beijerinckia* is present in Northern Australia. To the best of my knowledge it is the first time that these organisms have been detected in this country.

(2) The distribution of *Beijerinckia* in Australia seems to be limited to the north of 17–18° latitude. It is likely to be absent south of the 20° latitude.

(3) The ecological factors of the distribution of *Beijerinckia* in Australia are still not understood. Some chemical, geological and climatic factors are discussed.

(4) A suggestion has been made to divide the world into three zones, according to the distribution of non-symbiotic N-fixing micro-organisms: (*a*) tropical zone with the presence of *Beijerinckia*, *Azotobacter*, *Clostridium* and blue-green algae; (*b*) temperate zone with *Azotobacter*, *Clostridium* and blue-green algae; (*c*) arctic and antarctic zone with *Clostridium* and blue-green algae.

This suggestion is purely hypothetical but may provide a starting point for future research.

Acknowledgements.

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EXPLANATION OF PLATE X, FIGS. 3, 4.

Fig. 3.—Photomicrograph of *Beijerinckia* in mixed culture.

Fig. 4.—Top: Colonies of *Beijerinckia* on N-free medium three weeks old. Lower right: Colonies of *Azotobacter*, same age. Lower left: Colonies of other bacteria.

A NEW SPECIES OF *PSEUDOPHRYNE* FROM VICTORIA.

By John A. Moore, Fulbright Research Scholar, Sydney University.

(One Text-figure.)

[Read 29th July, 1953.]

The Australian Museum has in its collections an undescribed *Pseudophryne* of a most striking kind. It is represented by a single specimen. The basing of a new species on a single specimen is a hazardous procedure, but in this instance I think it is justified in view of the unusual characteristics shown by the specimen. There is no other *Pseudophryne* that has even a remote resemblance.

Pseudophryne corroboree, n. sp.

Type: R 13103, a male in the Australian Museum, Sydney. Collected by Ossie Rixon at Towong Hill Station, Corryong, Victoria. Donated by T. W. Mitchell. The type locality is near the Victoria–New South Wales border, about 25 miles north-west of Mount Kosciusko.

Pseudophryne corroboree in dorsal (left) and ventral (right) views. Approximately twice natural size.

Description: A *Pseudophryne* having the same general structural features as *P. australis* (Gray) and *P. bibroni* Günther. Body length 24 mm.; tibia 7·9 mm.; width of head at posterior end of jaws 7·0 mm.; tip of snout to centre of nares 1·1 mm.; centre of nares to anterior corner of eye 1·7 mm.; anterior-posterior dimension of eye 2·2 mm. The three dimensions last given were obtained by viewing the specimen laterally under a binocular microscope and the measurements made with an ocular scale. The fourth toe reaches the snout when the leg is extended along the side of the body. The shape of the head and the structure of the hand and foot are the same as in *P. australis* and

P. bibroni. A detailed description of these and other members of the genus will be found in Parker (1940).

This species differs from all others of the genus in its unusual dorsal pattern, which can be best appreciated by reference to the figure. In the type the dark bands are black and the light areas pale yellow. Dark and light areas of similar tones cover the entire body. The tubercles at the base of the fingers and on the metacarpals are light, contrasting strongly with the dark background. Many of the tubercles of the foot, including the inner metatarsal tubercle, are likewise light in colour against a dark background. The postfemoral glands cannot be distinguished externally, but the area where they occur in other species of *Pseudophryne* is light in colour.

Diagnosis: *Pseudophryne corroboree* can be distinguished from all other species of the genus and from all other Australian frogs by the boldly contrasting dark and light stripes on the dorsal surface.

The specific name was suggested by the resemblance of the dorsal pattern of *P. corroboree* to the body paintings used by some Australian aboriginal tribes in their corroborees.

When specimen R 13103 was received at the Australian Museum, Mr. Kinghorn realized that it was an undescribed species and attempted to secure more information and specimens. No additional specimens have been received, but this excerpt of a letter from Mr. Mitchell is of interest: "It was found at the foot of a fence post at the foot of the Round Mountain. After getting your letter asking for information I questioned the finder, one Ossie Rixon. He said that he has seen them before about the Round Mountain and also about the Fifteen Mile. He said 'they are rare but you do see them . . . generally about the cattle pads . . . they don't hop like a frog but sort of go along on all fours right up on their toes . . . they don't squat like a frog . . .'." This type of locomotion is common in other species of *Pseudophryne*.

I am indebted to Mr. Kinghorn for allowing me to describe this species.

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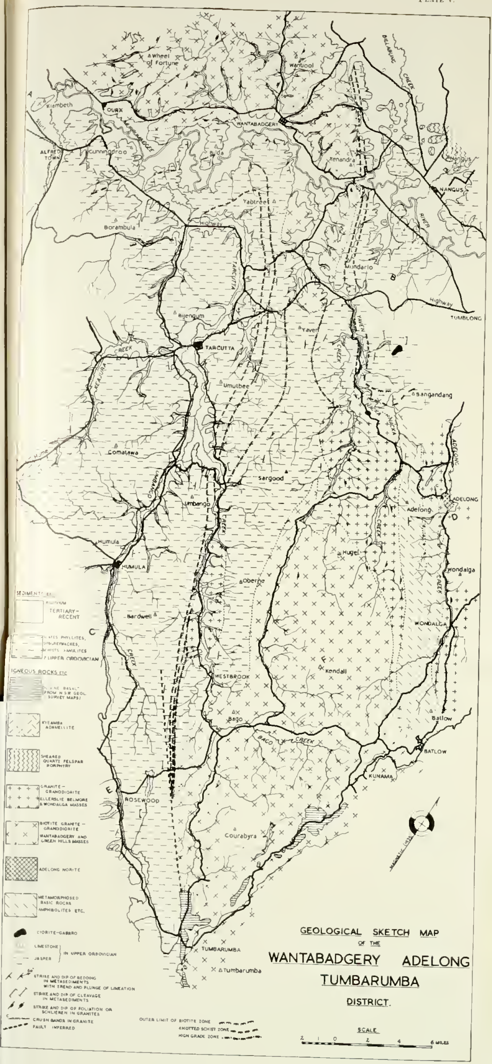
GEOLOGICAL SKETCH MAP
OF THE
WANTABADGERY ADELONG
TUMBARUMBA
DISTRICT.
SCALE
2 1 0 2 4 6 MILES
TERTIARY-RECENT
? UPPER ORDOVICIAN
IGNEOUS ROCKS ETC.
KYEAMBA ADAMELLITE
SHEARED QUARTZ FELSPAR PORPHYRY
GRANITE-GRANODIORITE
ELLERSLIE BELMORE & WONDALGA MASSES
BIOTITE GRANITE-GRANODIORITE
WANTABADGERY AND GREEN HILLS MASSES
ADELONG NORITE
METAMORPHOSED BASIC ROCKS AMPHIBOLITES ETC.
DIORITE-GABBRO
LIMESTONE
JASPER
IN UPPER ORDOVICIAN
STRIKE AND DIP OF BEDDING IN METASEDIMENTS WITH TREND AND PLUNGE OF LINEATION
STRIKE AND DIP OF CLEAVAGE IN METASEDIMENTS
STRIKE AND DIP OF FOLIATION OR SCHLIEREN IN GRANITES
CRUSH BANDS IN GRANITE
FAULT INFERRED
OUTER LIMIT OF BIOTITE ZONE
KNOTTED SCHIST ZONE
HIGH GRADE ZONE
Wheel of Fortune
Wantool
BILLABUNG CREEK
Kiambeth
OURA
WANTABADGERY
ALFRED TOWN
Cunningdroo
Bilda
Tenandra
Nangus
NANGUS
Yabtree
Borambula
Highway
RIVER
Mundarlo
Highway
TUMBLONG
TARCUTTA
Ajjengum
TARCUTTA
Yaven
YAVEN CREEK
Umutbee
Bangandang
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Kendall
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Batlow
BATLOW
KUNAMA
ROSEWOOD
Courabyra
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